

## Gastrointestinal Helminths of Five Horned Lizard Species, *Phrynosoma* (Phrynosomatidae) from Arizona

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**ABSTRACT:** Five species of horned lizards of the genus *Phrynosoma* from Arizona were examined for gastrointestinal helminths. *Phrynosoma cornutum* ( $N = 7$ ) and *Phrynosoma solare* ( $N = 8$ ) harbored the cestode *Diochetos phrynosomatis* and the nematodes *Atractis penneri* and *Skrjabinoptera phrynosoma*. *Phrynosoma douglassii* ( $N = 19$ ) and *Phrynosoma platyrhinos* ( $N = 5$ ) contained both species of nematodes, whereas *Phrynosoma modestum* ( $N = 5$ ) harbored only *S. phrynosoma*. *Phrynosoma cornutum* and *P. douglassii* are new hosts for *A. penneri*; *P. modestum* is a new host for *S. phrynosoma*. It appears that gastrointestinal helminths of Arizona horned lizards are restricted to 3 species. *Diochetos parvovaria* is placed in synonymy with *D. phrynosomatis*.

**KEY WORDS:** Phrynosomatidae, *Phrynosoma cornutum*, *Phrynosoma douglassii*, *Phrynosoma mcallii*, *Phrynosoma modestum*, *Phrynosoma platyrhinos*, *Phrynosoma solare*, Cestoda, *Diochetos parvovaria*, *Diochetos phrynosomatis*, Nematoda, *Atractis penneri*, *Skrjabinoptera phrynosoma*, prevalence, intensity.

Six species of horned lizards, *Phrynosoma*, occur in Arizona (see Stebbins, 1985). The Texas horned lizard, *Phrynosoma cornutum* (Harlan, 1825), ranges from Kansas through the Gulf Coast of Texas and extreme southeastern Arizona to Durango and Tamaulipas, Mexico, in dry areas of open country from sea level to 1,830 m elevation. The short-horned lizard, *Phrynosoma douglassii* (Bell, 1828), ranges from southern Canada through the western United States to Durango, Mexico, in open rocky or sandy plains and forests at elevations of 170–3,440 m. The flat-tail horned lizard, *Phrynosoma mcallii* (Hallowsell, 1852), occurs in the Coachella Valley of southern California to northeast Baja California and southwestern Arizona in regions of wind-blown sand from below sea level to 180 m elevation. The roundtail horned lizard, *Phrynosoma modestum* Girard, 1852, ranges from west Texas, northern New Mexico and southeastern Arizona to San Luis Potosí, Mexico, in semiarid regions of scrub vegetation from 210 to 1,850 m elevation. The desert horned lizard, *Phrynosoma platyrhinos* Girard, 1852, ranges from southern Idaho and southeastern Oregon to northeastern Baja California and northwestern Sonora, Mexico, in areas of sandy, gravelly soil with scrub vegetation, from sea level to 1,980 m elevation. The regal horned lizard, *Phrynosoma solare* Gray, 1845, ranges from central Arizona to northern Sinaloa, Mexico, in scrub vegetation at elevations from sea level to 1,460 m.

Helminths have been reported previously from *Phrynosoma cornutum*, *P. douglassii*, *P. mcallii*, *P. platyrhinos*, and *P. solare* (Table 1), but to our knowledge there are no reports of helminths from *P. modestum*. The purpose of this report is to present data on helminth prevalences and intensities for the 6 species of *Phrynosoma* occurring in Arizona. Our specimens of *P. mcallii* were collected from Sonora, Mexico, just south of the Arizona border.

### Materials and Methods

Specimens of *Phrynosoma cornutum*, *P. douglassii*, *P. mcallii*, and *P. solare* were borrowed from the Herpetology Collection, Natural History Museum of Los Angeles County (LACM); *P. modestum* and *P. platyrhinos* were borrowed from the Herpetology Collection, Department of Zoology, Arizona State University (ASU). The number of specimens of each species examined, body size as snout–vent length (SVL), and collection dates are given in Table 2. Museum accession numbers and collection site longitudes, latitudes, and elevations are given in Appendix 1.

The body cavity was opened by a longitudinal incision from vent to throat, and the gastrointestinal tract was excised by cutting across the esophagus and rectum. The esophagus, stomach, small intestine, and large intestine were slit longitudinally and examined under a dissecting microscope. Each helminth was placed on a microscope slide in a drop of undiluted glycerol. A coverslip was added, and the slide was set aside until the helminth became transparent. Each helminth was identified using this glycerol wet-mount method. Selected cestodes were stained with Delafield's hematoxylin and mounted in Canada balsam. Selected intact specimens were placed in vials of 70% ethanol and

**Table 1.** Previously reported helminths from the species of *Phrynosoma* occurring in Arizona.

Host Helminth	Locality	Prevalence	Reference
<i>Phrynosoma cornutum</i>			
<i>Diochetos phrynosomatis</i>	Kansas	17% (1/6)	Loewen, 1940
	Oklahoma	100% (1/1)	Steelman, 1939
	Texas	57% (4/7)	Harwood, 1932
	Texas	48% (13/27)	Vincent, 1948
<i>Skrjabinoptera phrynosoma</i>	Mexico, Arizona	Not given	Caballero, 1937
	New Mexico	100% (8/8)	Morgan, 1942
	Oklahoma	30% (12/40)	Morgan, 1942
	Texas	95% (19/20)	Morgan, 1942
	Texas	75% (18/24)	Lee, 1955
	Texas	43% (3/7)	Harwood, 1932
	Texas	63% (17/27)	Vincent, 1948
<i>Phrynosoma douglassii</i>			
<i>Skrjabinoptera phrynosoma</i>	Mexico, Arizona	Not given	Caballero, 1937
	Mexico	Not given	Morgan, 1942
<i>Phrynosoma mcallii</i>			
<i>Skrjabinoptera phrynosoma</i>	California	100% (2/2)	Telford, 1970
<i>Phrynosoma platyrhinos</i>			
<i>Diochetos phrynosomatis</i>	Idaho	40% (4/10)	Lyon, 1986
	Nevada	11% (11/104)	Babero and Kay, 1967
	Utah	Not given	Grundmann, 1959
<i>Atractis penneri</i>	California	100% (1/1)	Telford, 1970
	Idaho	33% (1/3)	Waitz, 1961
	Idaho	40% (4/10)	Lyon, 1986
	Nevada	43% (45/104)	Babero and Kay, 1967
	Utah	Not given	Grundmann, 1959 (see Telford, 1964)
<i>Skrjabinoptera phrynosoma</i>	California, Idaho, Utah	Not given	Morgan, 1942
	California	67% (2/3)	Telford, 1970
	Idaho	33% (1/3)	Waitz, 1961
	Idaho	60% (6/10)	Lyon, 1986
	Nevada	97% (101/104)	Babero and Kay, 1967
	Utah	100% (7/7)	Woodbury, 1934
	Utah	Not given	Grundmann, 1959
<i>Phrynosoma solare</i>			
<i>Diochetos phrynosomatis</i>	Arizona	29% (4/14)	Benes, 1985
<i>Atractis penneri</i>	Arizona	21% (3/14)	Benes, 1985
<i>Skrjabinoptera phrynosoma</i>	Arizona	75%	Hannum, 1941
	Arizona	79% (11/14)	Benes, 1985
	Mexico, Arizona	Not given	Caballero, 1937

deposited in the USNM Helminthological Collection, USDA, Beltsville, Maryland 20705 (for accession numbers, see Appendix 1).

**Results and Discussion**

One species of cestode, *Diochetos phrynosomatis* Harwood, 1932, and 2 nematodes, *Atractis penneri* (Gambino, 1957) Baker, 1987, and *Skrjabinoptera phrynosoma* (Ortlepp, 1922) Schulz, 1927, were found. Prevalences, mean intensities, and site of infection are given in Table 3.

*Diochetos phrynosomatis* was originally described from *P. cornutum* from Houston and Anderson counties, Texas (Harwood, 1932), and is currently known only from the genus *Phrynosoma*. A second species, *D. parvovaria* Steelman, 1939, taken from a single *P. cornutum* collected in Stillwater, Oklahoma, has been described but has not been reported since. Steelman (1939) based his description on 52 specimens of *D. parvovaria* ranging in length from 5 to 22 mm and having 52–87 testes per segment. Harwood (1932) reported 55–70-mm lengths and 125–180 testes

Table 2. Collection location, year of collection, and mean size of the 6 species of *Phrynosoma* examined in this study.

Species	Arizona County	N	Collection year	Mean SVL (range in mm)
<i>Phrynosoma cornutum</i>	Cochise	7	1966–1967	76 (30–89)
<i>Phrynosoma douglassii</i>	Pima	17	1966–1967	65 (32–91)
	Graham	1	1966	83 (—)
	Santa Cruz	1	1967	82 (—)
<i>Phrynosoma mcallii</i>	—*	2	1963	64 (62–65)
<i>Phrynosoma modestum</i>	Graham	2	1966	59 (58–59)
	Cochise	1	1973	58 (—)
	Maricopa	2	1971	64 (58–69)
<i>Phrynosoma platyrhinos</i>	Yuma	3	1974	73 (72–74)
	Pinal	2	1956	70 (69–71)
<i>Phrynosoma solare</i>	Pima	8	1966	94 (77–113)

\* Mexican side of the Mexico–Yuma County border.

per segment for *D. phrynosomatis*. Egg and oncosphere diameters were reported to be similar for both cestodes: 49–71 and 26–46  $\mu\text{m}$ , respectively, for *D. parvovaria* as compared to 55 and 30  $\mu\text{m}$ , respectively, for *D. phrynosomatis*. In our samples, gravid *D. phrynosomatis* from a single host ranged from 20 to 65 mm in length and had 70–150 testes per segment. The differences between *D. parvovaria* and *D. phrynosomatis* as enumerated by Steelman (1939) were related to size: *D. parvovaria* was about one-third the length of *D. phrynosomatis*, the scolex and suckers were smaller, the segments became mature relatively

nearer the scolex, and the testes were half as numerous. Because there are no unique morphological characteristics, the differences can be explained by dwarfing, and because our measurements overlap both descriptions we have placed *D. parvovaria* in synonymy with *D. phrynosomatis* and included it in Table 1. The dwarfing of helminths by crowding has been well documented (Morgan, 1942; Babero and Kay, 1967; Brooks and Mayes, 1976; Bursey and Goldberg, 1992). In addition to the hosts listed in Table 3, *D. phrynosomatis* has been reported from the Mexican horned lizards, *Phrynosoma bracon-*

Table 3. Helminths recovered from 5 species of *Phrynosoma* collected in Arizona.

Host Helminth	Prevalence	Mean intensity (range)	Site
<i>Phrynosoma cornutum</i>			
<i>Diocetos phrynosomatis</i>	71% (5/7)	86 (22–181)	Small and large intestine
* <i>Atractis penneri</i>	14% (1/7)	137	Large intestine
<i>Skrjabinoptera phrynosoma</i>	86% (6/7)	611 (9–1,579)	Stomach
<i>Phrynosoma douglassii</i>			
* <i>Atractis penneri</i>	11% (2/19)	476 (323–636)	Small and large intestine
<i>Skrjabinoptera phrynosoma</i>	11% (2/19)	47 (34–60)	Stomach and small intestine
<i>Phrynosoma modestum</i>			
* <i>Skrjabinoptera phrynosoma</i>	80% (4/5)	5 (1–13)	Stomach, small intestine, and lung
<i>Phrynosoma platyrhinos</i>			
<i>Atractis penneri</i>	40% (2/5)	511 (396–625)	Large intestine
<i>Skrjabinoptera phrynosoma</i>	40% (2/5)	8 (6–10)	Stomach
<i>Phrynosoma solare</i>			
<i>Diocetos phrynosomatis</i>	100% (8/8)	30 (21–70)	Small intestine
<i>Atractis penneri</i>	63% (5/8)	1,113 (2–2,364)	Large intestine
<i>Skrjabinoptera phrynosoma</i>	100% (8/8)	524 (16–1,804)	Stomach and small and large intestines

\* New host record.

*nieri* (prevalence 9%, 1/11) and *Phrynosoma taurus* (prevalence 20%, 1/5) by Goldberg and Bursey (1991). The mean prevalence for the 5 species harboring *D. phrynosomatis* is 27% (53/200). The life cycle for *D. phrynosomatis* is not known; however, insects and mites serve as intermediate hosts for anoplocephalid cestodes (Schmidt, 1986).

*Atractis penneri* is 1 of 2 species of *Atractis* reported to occur in the United States. The other species, *Atractis scelopori*, has been reported from southern California (Kern, Los Angeles, and Riverside counties) and southern Nevada (Clark County) as well as Mexico from large herbivorous lizards (see Gambino and Heyneman, 1960). It is distinguished from *A. penneri* in that it has equal spicules and 6 prominent lip papillae. *Atractis penneri* is a parasite of carnivorous phrynosomatid and crotaphytid lizards infecting some 21 North American species from Idaho to Texas. These 2 species of *Atractis* overlap only in southern California. The life cycle of *A. penneri* is apparently direct, like that of other attractids (Cheng, 1986). Baer (1951) has suggested that these nematodes, which occur in large numbers and in all stages of development, are possibly living on partially digested vegetable matter and should be considered as commensals rather than true parasites. *Phrynosoma cornutum* and *P. douglassii* are new hosts for *A. penneri*.

*Skrjabinoptera phrynosoma*, the only member of the genus *Skrjabinoptera* reported from the United States, is the most commonly found nematode of horned lizards, although it has been reported from both crotaphytid, phrynosomatid, polychrid, and teiid lizards (see Goldberg and Bursey, 1991). Lee (1957) showed experimentally that the ant *Pogonomyrmex barbatus* served as an intermediate host for *S. phrynosoma*. Pearce and Tanner (1973) suggested that several species of ants may serve as intermediate hosts for this nematode. The number of *S. phrynosoma* present has been found to be roughly related to the size of the lizard. Lee (1957) reported never finding *S. phrynosoma* in the stomachs of *P. cornutum* under 50 mm SVL, at which size they change their diet from exclusively small ants to include the larger ant *P. barbatus*. Benes (1985) found *S. phrynosoma* in the stomachs of *P. solare* measuring 35 mm SVL and suggested they may begin to feed on *P. barbatus* at an earlier age than does *P. cornutum*. Although our specimens ranged from 30 to 113 mm SVL, the smallest infected horned lizard in our study was a *P. modestum*

of 58 mm SVL. *Phrynosoma modestum* is a new host for *S. phrynosoma*. The 2 *P. mcallii* that we examined from the state of Sonora, Mexico, were also infected with 67 and 90 *S. phrynosoma*.

Based on our observations and previous reports from the literature (Table 1), we conclude that the gastrointestinal helminth community of Arizona horned lizards is restricted to 3 helminths: *D. phrynosomatis*, *A. penneri*, and *S. phrynosoma*. The similarity of helminth faunas among species of horned lizards may be related to diet. Pianka and Parker (1975) found the bulk of the diet of species of *Phrynosoma* to consist of ants, and for the 6 species that we examined the percentage of ants by number of prey items in their study ranged from 97% in *P. mcallii* to 69% in *P. cornutum*. Because ants serve as the intermediate host (Lee, 1957), a high prevalence of *S. phrynosoma* in horned lizards might be expected. As a corollary, because *D. phrynosomatis* is restricted to horned lizards, it is conceivable that an ant may also serve as the intermediate host for this species. Finally, because *A. penneri* has a direct life cycle (Cheng, 1986) and occurs in many North American lizard species (see Baker, 1987), it is possible that these infections may be passed, perhaps by fecal contamination of substrate or food, among sympatric lizard species.

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#### Appendix 1: Museum Accession Numbers, Locality Data, and USNM Helminthological Collection Numbers

- P. cornutum*: Cochise County, LACM 140076-140080, 32°14'N, 109°45'W; elevation 1,269 m; LACM 140075, 32°31'N, 109°58'W, elevation 1,345 m; LACM 140081, 31°41'N, 109°08'W, elevation 1,335 m. USNM Helminthological Collection numbers: *Diocetos phrynosomatis* 82641; *Atractis penneri* 82642; *Skrjabinoptera phrynosoma* 82640.
- P. douglassii*: Pima County, LACM 140056-140059, 140061-140066, 140068-140074, 32°26'N, 110°45'W, elevation 2,438 m; Santa Cruz County, LACM 140067, 31°42'N, 110°46'W, elevation ca. 1,524 m; Graham County, LACM 140060, 32°41'N, 109°52'W, elevation 3,108 m. USNM Helminthological Collection numbers: *A. penneri* 82644; *S. phrynosoma* 82643.
- P. mcallii*: Sonora, Mexico, LACM 140054-140055, 32°27'N, 115°18'W, elevation 50 m. USNM Helminthological Collection number: *S. phrynosoma* 82645.
- P. modestum*: Graham County, ASU 7267, 7866, 32°44'N, 109°42'W, elevation 1,036 m; Cochise County, ASU 14317, 32°12'N, 109°34'W; elevation ca. 1,950 m; Maricopa County, ASU 21471, 21472, 33°32'N, 111°39'W; elevation ca. 420 m. USNM Helminthological Collection number: *S. phrynosoma* 82646.
- P. platyrhinos*: Yuma County, ASU 15966, 15969-15970, 33°58'N, 114°28'W, elevation 203 m; Pinal County, ASU 5841, 5843, 32°33'N, 111°31'W, elevation 506 m. USNM Helminthological Collection numbers: *A. penneri* 82651; *S. phrynosoma* 82650.
- P. solare*: Pima County, LACM 140082-140083, 140086-140089, 32°20'N, 110°49'W, elevation ca. 907 m; LACM 140084, 32°01'N, 111°37'W, elevation 975 m, LACM 140085, 32°18'N, 111°09'W, elevation 796 m. USNM Helminthological Collection numbers: *D. phrynosomatis* 82648; *A. penneri* 82649; *S. phrynosoma* 82647.